CAN YOU WIN?

Suggested Grades

8-10, Algebra I

SD Mathematics Strand & Standard *(Primary for Task)*

Statistics & Probability

9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.

Task Summary

Students will explore experimental and theoretical probability by examining their chances of winning the lottery.

Time and Context of Task

One class period. This activity should be attempted after students are proficient in calculating probabilities.

Materials Needed

Powerball play tickets, slips of paper or ping pong balls for drawing

Author and Lead Teacher for This Task

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Modified from activity in McDougal Littell Pre-Algebra textbook.

CAN YOU WIN?

A lottery has been defined by some as "a tax on people who are bad at math." One of the lotteries offered in South Dakota is Powerball. To play Powerball, the player selects 5 numbers from 1 to 53 and the "powerball" number 1-42. You will be given photocopies of two Powerball play tickets to choose the numbers for 10 plays. When the entire class has completed the play tickets, the "winning numbers" will be selected from numbers in a bingo set. Based on the class results, you will determine the experimental probability of winning the jackpot. You will also calculate the theoretical probability for winning the jackpot. You will write a short paper explaining the difference between the two types of probabilities and which is more accurate for playing Powerball.

CONTENT STANDARDS

Primary Standard

Strand Name: Statistics & Probability
SD Goal: Students will apply statistical methods to analyze data and explore probability for making decisions and predictions.
Indicator: Apply the concepts of probability to predict events/outcomes and solve problems.
Standard: 9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.

Supplemental Standard

Strand Name: Statistics & Probability
SD Goal: Students will apply statistical methods to analyze data and explore probability for making decisions and predictions.
Indicator: Apply the concepts of probability to predict events/outcomes and solve problems.
Standard: 9-12.S.2.2. Students are able to predict outcomes of simple events using given theoretical probabilities.

NCTM Process Standards

Connections: Recognize and apply mathematics in contexts outside of mathematics.
Communication: Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Problem-Solving Strategies

- Developing formulas and writing equations
- Use of manipulatives

ASSESSMENT TOOLS

Task Rubric

Category	Advanced	Proficient	Basic	Below Basic
9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.	Correctly identifies the experimental and theoretical probability in the task and explains the difference. Explanation includes experiment modifications that could be made.	Correctly identifies the experimental and theoretical probability in the task and explains the difference.	Correctly identifies the experimental and theoretical probability in the task with no explanation	Does not distinguish between experimental and theoretical probability
9-12.S.2.2. Students are able to predict outcomes of simple events using given theoretical probabilities.	Correctly calculate the probabilities for all winning powerball combinations and the experimental probability.	Correctly calculates the probability for winning the powerball jackpot and the experimental probability for winning the jackpot.	Incorrectly calculates the probability for winning the powerball jackpot or the experimental probability for winning the jackpot.	Incorrectly calculates the probability for winning the powerball jackpot and the experimental probability for winning the jackpot.

Core High School Statistics & Probability
Performance Descriptors

Advanced	**High school students performing at the advanced level:** • calculate probability of compound events; • determine correlation coefficient in a data set.
Proficient	**High school students performing at the proficient level:** • calculate probability of a simple event and make predictions; • answer questions about measures of central tendency and five-number summary based on a given data set; • draw a regression line for a scatterplot.
Basic	**High school students performing at the basic level:** • calculate the probability of a simple event; • calculate mean, median, and mode for a data set.

High School Statistics & Probability
ELL Performance Descriptors

Proficient	**High school ELL students performing at the proficient level:** • determine measures of central tendency; • draw a regression line for a scatterplot; • determine probability of independent or dependent events orally or in writing; • read, write, and speak the language of statistics and probability and apply it to statistics and probability problem-solving situations.
Intermediate	**High school ELL students performing at the intermediate level:** • demonstrate usage of statistics and probability concepts; • determine range, mode, median, and mean in given data sets; • recognize and use a scatterplot; • use statistics and probability terms to explain the sequence of steps and/or strategies used in solving problems; • give simple oral, pictorial, symbolic (diagrams) or written responses to questions on topics presented in class.
Basic	**High school ELL students performing at the basic level:** • determine range, mode, and median in given data sets; • demonstrate problem-solving strategies; • break tasks into smaller parts and make connections to prior knowledge; • recognize, compare, and use appropriate statistics and probability terms; • respond to yes or no questions and to problems presented pictorially or numerically in class.
Emergent	**High school ELL students performing at the emergent level:** • respond to problems to determine median in given data sets; • copy and write statistics and probability symbols and figures; • imitate pronunciation of statistics and probability terms; • use non-verbal communication to express mathematical ideas.
Pre-emergent	**High school ELL students performing at the pre-emergent level:** • observe and model appropriate cultural and learning behaviors from peers and adults; • listen to and observe comprehensible instruction and communicate understanding non-verbally.

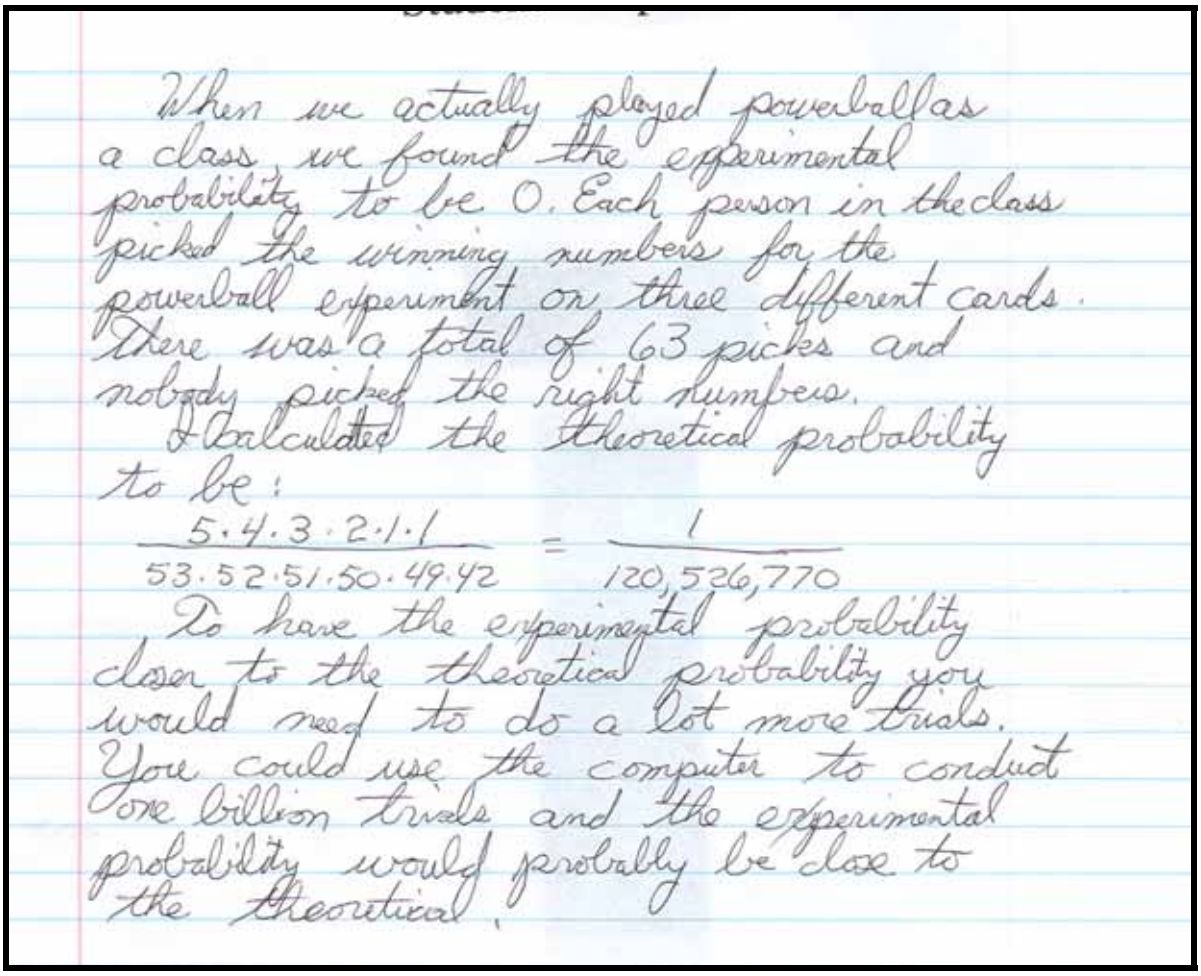
CAN YOU WIN?

Student Work Samples

As you examine the samples, consider the following questions:

- In light of the standard/s addressed and the assessment tools provided, what evidence does the work provide that students are achieving proficiency in the knowledge and skills addressed by the standard/s for the task?
- Is the task/activity well designed to help students acquire knowledge and demonstrate proficiency? Is the task/activity clearly aligned with the standards? In what ways would you adapt the task/activity to better meet the needs of your students?

Student Work Sample #1



When we actually played powerball as a class, we found the experimental probability to be 0. Each person in the class picked the winning numbers for the powerball experiment on three different cards. There was a total of 63 picks and nobody picked the right numbers.

I calculated the theoretical probability to be:

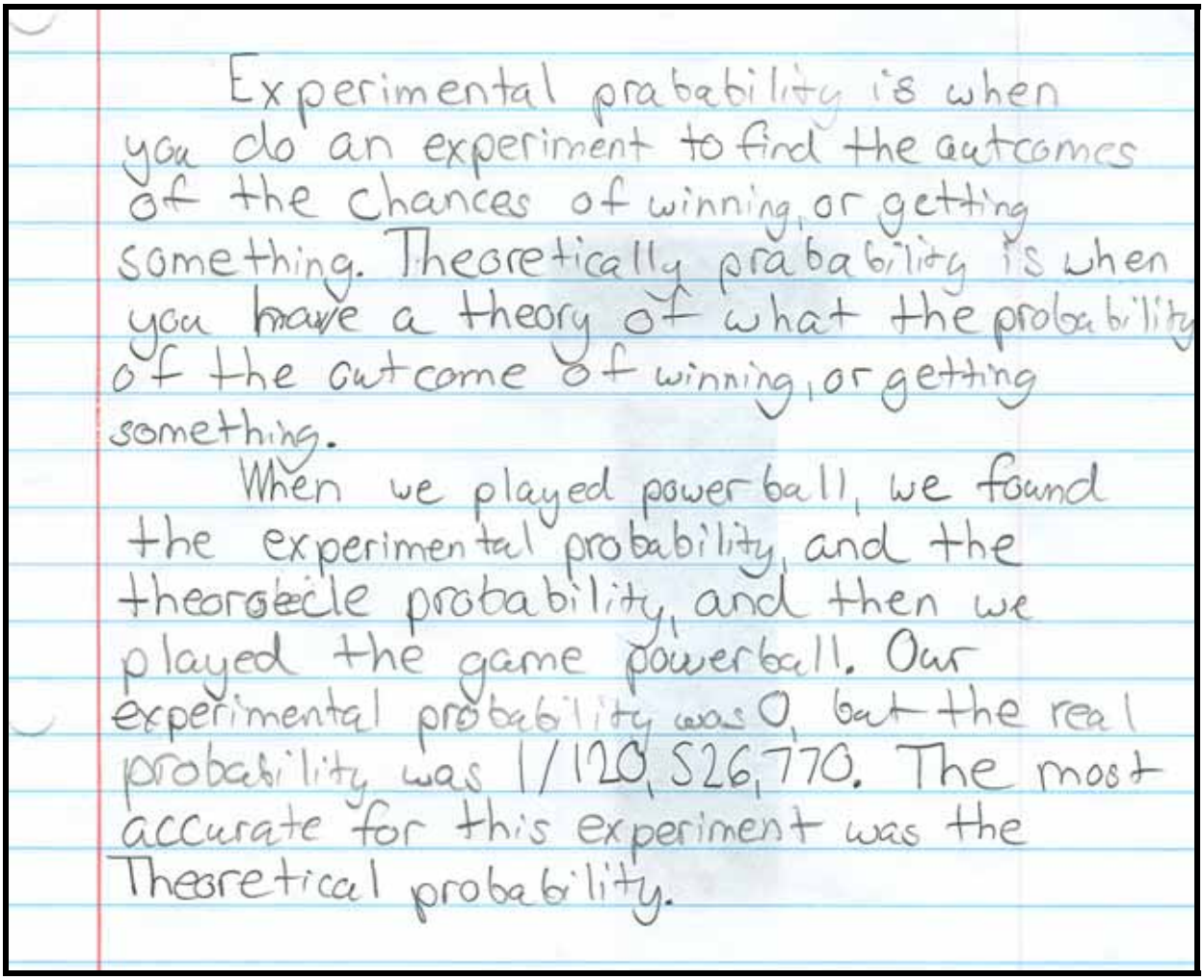
$$\frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 \cdot 1}{53 \cdot 52 \cdot 51 \cdot 50 \cdot 49 \cdot 42} = \frac{1}{120,526,770}$$

To have the experimental probability close to the theoretical probability you would need to do a lot more trials. You could use the computer to conduct one billion trials and the experimental probability would probably be close to the theoretical.

Looking at Student Work – Instructor notes and rating for work sample #1:

Category	Student Sample 1	
9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.	Advanced	The student correctly identified the experimental and theoretical probability. The answer indicates the student understands the difference between experimental and theoretical probability. The probabilities for other powerball winnings were not calculated.
9-12.S.2.2. Students are able to predict outcomes of simple events using given theoretical probabilities.	Proficient	

Student Work Sample #2



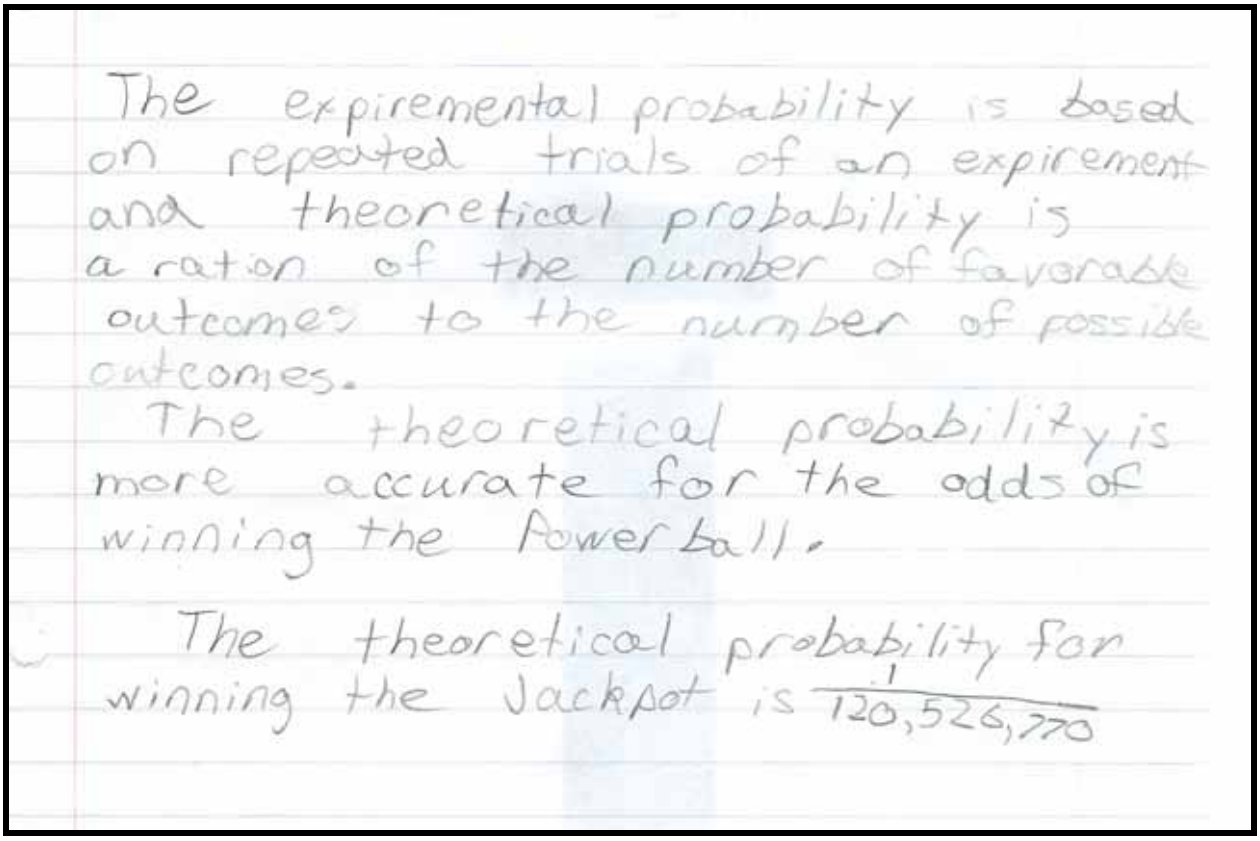
Experimental prabability is when you do an experiment to find the outcomes of the chances of winning, or getting something. Theoretically prabability is when you have a theory of what the probability of the outcome of winning, or getting something.

When we played powerball, we found the experimental probability, and the theorotecle probability, and then we played the game powerball. Our experimental probability was 0, but the real probability was 1/120,526,770. The most accurate for this experiment was the Theoretical probability.

Looking at Student Work – Instructor notes and rating for work sample #2:

Category	Student Sample 2	Student correctly identified the experimental and theoretical probability and calculated both but not offer any suggestions for experiment modifications that could be made. The probabilities for other powerball winnings were not calculated.
9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.	Proficient	
9-12.S.2.2. Students are able to predict outcomes of simple events using given theoretical probabilities.	Proficient	

Student Work Sample #3


The expiremental probability is based on repeated trials of an expirement and theoretical probability is a ration of the number of favorable outcomes to the number of possible outcomes.

The theoretical probability is more accurate for the odds of winning the Powerball.

The theoretical probability for winning the Jackpot is $\frac{1}{120,526,770}$

Looking at Student Work – Instructor notes and rating for work sample #3:

Category	Student Sample 3	
9-12.S.2.1. Students are able to distinguish between experimental and theoretical probability.	Basic	The student's answer indicates a general understanding of experimental and theoretical probability but not necessarily as related to powerball. The theoretical probability was correctly calculated but no mention was made of the experimental probability that was found.
9-12.S.2.2. Students are able to predict outcomes of simple events using given theoretical probabilities.	Basic	

INSTRUCTIONAL NOTES

Author Comments
If a bingo set is not available, the numbers could be written on slips of paper or ping pong balls and selected in that way. The numbers could also be selected using a random number generator (computer of calculator.) As written, the students only calculate the probability of winning the jackpot. The problem could be extended to have them calculate the probability of winning lesser amounts then the jackpot.

Task Extensions
To give the students the idea of a concrete example of the probability, I have them calculate how long of a row of quarters laid side-by-side would equal the denominator of the probability fraction and explain that the chance of winning would be the same as picking 1 quarter that had been specially marked from that long line (without seeing the marking.)

Appropriate Technology
Graphing calculator or computer to generate random numbers if bingo set is not used

Interdisciplinary Connections
Study of gambling in Civics or current events. How has Powerball and other state sponsored gambling activities effected the state economy? How has addiction to gambling affected families and communities?

Teacher Resources
- www.sdlottery.org
- www.powerball.com

(Note: both of these websites may be blocked at school.)

Resources

SD Mathematics Content Standards
http://www.doe.sd.gov/contentstandards/math/index.asp
SD Assessment and Testing
http://www.doe.sd.gov/octa/assessment/index.asp
The National Assessment of Educational Progress (NAEP)
http://www.doe.sd.gov/octa/assessment/naep/index.asp
National Council of Teachers of Mathematics
http://nctm.org/
Looking at Student Work
http://www.lasw.org/index.html